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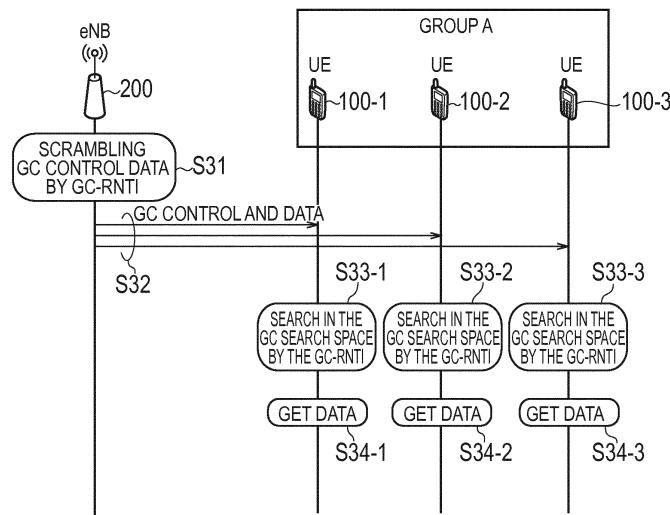
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### (54) MOBILE COMMUNICATION SYSTEM, BASE STATION, AND USER TERMINAL

(57) A mobile communication system includes an eNB 200 that manages a cell and transmits control information in a PDCCH region in a downlink subframe and a plurality of UEs 100 that constitute a terminal group in which group communication is performed in the cell. The PDCCH region includes a CSS in which control information common to all the UEs 100 in the cell is arranged and a USS in which control information specific to each of the UEs 100 in the cell is arranged. The PDCCH region

further includes a GCSS in which GC control information related to the group communication is arranged. The eNB 200 arranges the GC control information in the GCSS according to a GCRNTI allocated to be common to the plurality of UEs 100. Each of the plurality of UEs 100 acquires the GC control information arranged in the GCSS according to the GC-RNTI allocated to its own UE 100.

FIG. 9



**Description****TECHNICAL FIELD**

5 [0001] The present invention relates to a mobile communication system into which a group communication function is introduced.

**BACKGROUND ART**

10 [0002] In 3rd Generation Partnership Project (3GPP) that is a mobile communication system standardization project, a Multimedia Broadcast Multicast Service (MBMS) has been established (see Non-Patent Literature 1). In the MBMS, a plurality of user terminals receives an MBMS service that is provided from a network in a multicast or broadcast manner. For example, the MBMS service is a broadcast video delivery.

15 [0003] In 3GPP, standardization for newly introducing a group communication function is scheduled to be conducted in Release 12. For example, the group communication is a group call (voice over Internet protocol (VoIP)) based on packet communication. In the group communication, basically, unicasting is applied to uplink communication, and unicasting or multicasting is applied to downlink communication.

**CITATION LIST****20 NON PATENT LITERATURE**

[0004] Non patent Literature 1: 3GPP Technical Specification "TS36.300 V12.0.0," January 10, 2014

**25 SUMMARY OF INVENTION**

[0005] A mobile communication system according to an embodiment includes: a base station configured to manage a cell and transmit control information in a control region in a downlink sub frame; a plurality of user terminals configured to constitute a terminal group in which group communication is performed in the cell. The base station arranges group communication control information related to the group communication in a predetermined search space included in the control region according to a group communication identifier allocated to be common to the plurality of user terminals. Each of the plurality of user terminals acquires the group communication control information according to the group communication identifier allocated to its own user terminal.

**35 BRIEF DESCRIPTION OF DRAWINGS****[0006]**

40 Fig. 1 is a configuration diagram illustrating an LTE system according to first to third embodiments.  
 Fig. 2 is a block diagram illustrating a UE according to the first to third embodiments.  
 Fig. 3 is a block diagram illustrating an eNB according to the first to third embodiments.  
 Fig. 4 is a protocol stack diagram of a radio interface according to the first to third embodiments.  
 Fig. 5 is a diagram illustrating a radio frame according to the first to third embodiments.  
 Figs. 6(a) and 6(b) are diagrams for describing an operation according to the first embodiment.  
 Fig. 7 is a sequence diagram illustrating an operation when an eNB allocates a GC-RNTI according to the first embodiment.  
 Fig. 8 is a sequence diagram illustrating an operation when an EPC allocates a GC-RNTI according to the first embodiment.  
 Fig. 9 is a sequence diagram illustrating a group communication operation according to the first embodiment.  
 Figs. 10(a) and 10(b) are diagrams illustrating a first operation pattern according to a first modified example of the first embodiment.  
 Figs. 11(a) and 11(b) are diagrams illustrating a second operation pattern according to a first modified example of the first embodiment.  
 Figs. 12(a) to 12(c) are timing charts illustrating an operation according to a second modified example of the first embodiment.  
 Figs. 13(a) and 13(b) are diagrams for describing an operation according to the second embodiment.  
 Figs. 14(a) and 14(b) are diagrams for describing an operation according to the third embodiment.

## DESCRIPTION OF EMBODIMENTS

[Overview of embodiments]

5 [0007] A mobile communication system according to an embodiment includes: a base station configured to manage a cell and transmit control information in a control region in a downlink subframe; a plurality of user terminals configured to constitute a terminal group in which group communication is performed in the cell. The base station arranges group communication control information related to the group communication in a predetermined search space included in the control region according to a group communication identifier allocated to be common to the plurality of user terminals.

10 Each of the plurality of user terminals acquires the group communication control information according to the group communication identifier allocated to its own user terminal.

[0008] In an embodiment, the group communication identifier differs according to each terminal group.

[0009] In an embodiment, the group communication identifier is decided by the base station or a core network according to a request of a user terminal that desires to start the group communication. The base station notifies the user terminal of the request source of the decided group communication identifier.

[0010] In an embodiment, the base station transmits a message including a plurality of service identifiers that differ according to each terminal group and a plurality of group communication identifiers corresponding to the plurality of service identifiers in the cell in a broadcast manner.

[0011] In an embodiment, the group communication identifier is a fixed value specified on a system in advance. The group communication control information includes information for receiving radio resources included in a data region other than the control region. User data or the control information is arranged in the radio resources together with a service identifier that differs according to each terminal group.

[0012] In an embodiment, a user terminal that performs discontinuous reception (DRX) operation among the plurality of user terminals monitors control information different from the group communication control information in a first ON period, and monitors the group communication control information in a second ON period.

[0013] In an embodiment, the predetermined search space is a group communication search space in which the group communication control information related to the group communication is arranged.

[0014] In an embodiment, the predetermined search space is a common search space in which control information common to all the user terminals in the cell is arranged.

30 [0015] In an embodiment, the predetermined search space is a specific search space in which control information specific to each of the user terminals in the cell is arranged.

[0016] A base station according to an embodiment includes: a controller configured to manage a cell in which a plurality of user terminals constituting a terminal group performing group communication exist. The controller transmits control information in a control region in a downlink subframe. The controller arranges group communication control information related to the group communication in a predetermined search space included in the control region according to a group communication identifier allocated to be common to the plurality of user terminals.

[0017] A user terminal according to an embodiment includes: a controller configured to perform group communication in a cell managed by a base station that transmits control information in a control region in a downlink subframe. The controller acquires group communication control information related to the group communication arranged in a predetermined search space included in the control region according to a group communication identifier allocated to its own user terminal.

[First embodiment]

45 [0018] Hereinafter, exemplary embodiments when the present invention is applied to an LTE system that is a mobile communication system based on the 3GPP standard will be described.

## (1) System configuration

50 [0019] A system configuration of an LTE system according to the first embodiment will be described below. Fig. 1 is a configuration diagram illustrating the LTE system according to the first embodiment.

[0020] The LTE system according to the first embodiment includes user equipments (UEs) 100, an evolved-UMTS terrestrial radio access network (E-UTRAN) 10, and an evolved packet core (EPC) 20 as illustrated in Fig. 1.

55 [0021] The UE 100 corresponds to a user terminal. The UE 100 is a mobile communication apparatus, and performs radio communication with a cell (a serving cell). A configuration of the UE 100 will be described later.

[0022] The E-UTRAN 10 corresponds to a radio access network. The E-UTRAN 10 includes evolved Node-Bs (eNBs) 200. The eNB 200 corresponds to a base station. The eNBs 200 are connected to one another via an X2 interface. A configuration of the eNB 200 will be described later.

[0023] The eNB 200 manages one or more cells, and performs radio communication with the UE 100 that has established a connection with its own cell. The eNB 200 has a radio resource management (RRM) function, a user data routing function, a measurement control function for mobility control/scheduling, and the like. A "cell" is used as not only a term indicating a minimum unit of a radio communication area but also a term indicating a function of performing radio communication with the UE 100.

[0024] The EPC 20 corresponds to a core network. The EPC 20 includes a mobility management entity (MME)/serving-gateway (S-GW) 300. The MME performs various kinds of mobility controls on the UE 100. The SGW performs user data transfer control. The MME/S-GW 300 is connected with the eNB 200 via an S1 interface. The E-UTRAN 10 and the EPC 20 constitute a network of the LTE system.

[0025] Fig. 2 is a block diagram illustrating the UE 100. The UE 100 includes a plurality of antennas 101, a radio transceiver 110, a user interface 120, a global navigation satellite system (GNSS) receiver 130, a battery 140, a memory 150, and a processor 160 as illustrated in Fig. 2. The memory 150 and the processor 160 constitute a controller. The UE 100 may not include the GNSS receiver 130. The memory 150 may be integrated with the processor 160, and this set (that is, a chip set) may be used as the processor 160'.

[0026] The antennas 101 and the radio transceiver 110 are used for transmission and reception of radio signals. The radio transceiver 110 converts a baseband signal (a transmission signal) output from the processor 160 into a radio signal and transmits the radio signal through the antennas 101. The radio transceiver 110 converts a radio signal received through the antennas 101 into a baseband signal (a reception signal) and outputs the baseband signal to the processor 160.

[0027] The user interface 120 is an interface with the user who carries the UE 100, and includes, for example, a display, a microphone, a speaker, various kinds of buttons, and the like. The user interface 120 receives an operation from the user, and outputs a signal indicating content of the operation to the processor 160. In order to obtain position information indicating a geographical position of the UE 100, the GNSS receiver 130 receives a GNSS signal and outputs the received signal to the processor 160. The battery 140 accumulates electric power to be supplied to the respective blocks of the UE 100.

[0028] The memory 150 stores a program executed by the processor 160 and information used for a process performed by the processor 160. The processor 160 includes a baseband processor that performs, for example, modulation, demodulation, encoding, and decoding of the baseband signal and a central processing unit (CPU) that performs various kinds of processes by executing the program stored in the memory 150. The processor 160 may include a codec that encodes and decodes audio and video signals. The processor 160 executes various kinds of processes which will be described later and various kinds of communication protocols.

[0029] Fig. 3 is a block diagram illustrating the eNB 200. The eNB 200 includes a plurality of antennas 201, a radio transceiver 210, a network interface 220, a memory 230, and a processor 240 as illustrated in Fig. 3. The memory 230 and the processor 240 constitute a controller. The memory 230 may be integrated with the processor 240, and this set (that is, a chip set) may be used as a processor.

[0030] The antenna 201 and the radio transceiver 210 are used for transmission and reception of radio signals. The radio transceiver 210 converts a baseband signal (a transmission signal) output from the processor 240 into a radio signal and transmits the radio signal through the antenna 201. The radio transceiver 210 converts a radio signal received by the antenna 201 into a baseband signal (a reception signal), and outputs the baseband signal to the processor 240.

[0031] The network interface 220 is connected with a neighboring eNB 200 via the X2 interface and connected with the MME/S-GW 300 via the S1 interface. The network interface 220 is used for communication performed on the X2 interface and communication performed on the S1 interface.

[0032] The memory 230 stores a program executed by the processor 240 and information used for a process performed by the processor 240. The processor 240 includes a baseband processor that performs, for example, modulation, demodulation, encoding, and decoding of the baseband signal and a CPU that performs various kinds of processes by executing the program stored in the memory 230. The processor 240 executes various kinds of processes which will be described later and various kinds of communication protocols.

[0033] Fig. 4 is a protocol stack diagram of a radio interface in the LTE system. A radio interface protocol is classified into first to third layers of an OSI reference model, and the first layer is a physical (PHY) layer as illustrated in Fig. 4. The second layer includes a medium access control (MAC) layer, a radio link control (RLC) layer, and a packet data convergence protocol (PDCP) layer. The third layer includes a radio resource control (RRC) layer.

[0034] The PHY layer performs encoding/decoding, modulation/demodulation, antenna mapping/demapping, and resource mapping/demapping. User data and control information are transmitted through a physical channel between the PHY layer of the UE 100 and the PHY layer of the eNB 200.

[0035] The MAC layer performs preferential control of data, a retransmission process by hybrid ARQ (HARQ), a random access sequence, and the like. User data and control information are transmitted through a transport channel between the MAC layer of the UE 100 and the MAC layer of the eNB 200. The MAC layer of the eNB 200 includes a scheduler for deciding transport formats (a transport block size and a modulation and coding scheme (MCS)) of an uplink and a

downlink and a resource block to be allocated to the UE 100.

[0036] The RLC layer transmits data to an RLC layer of a reception side using the functions of the MAC layer and the PHY layer. User data and control information are transmitted through a logical channel between the RLC layer of the UE 100 and the RLC layer of the eNB 200.

5 [0037] The PDCP layer performs header compression/decompression and encryption/decryption.

[0038] The RRC layer is defined only in a control plane in which control information is dealt with. Control information (an RRC message) for various kinds of settings is transmitted between the RRC layer of the UE 100 and the RRC layer of the eNB 200. The RRC layer controls the logical channel, the transport channel, and the physical channel in response to establishment, re-establishment, and release of the radio bearer. When there is a connection (an RRC connection) 10 between the RRC of the UE 100 and the RRC of the eNB 200, the UE 100 is in an RRC connected state, and otherwise, the UE 100 is in an RRC idle state.

[0039] A non-access stratum (NAS) layer positioned above the RRC layer performs session management, mobility management, and the like.

[0040] Fig. 5 is a diagram illustrating a radio frame used in the LTE system. In the LTE system, Orthogonal Frequency Division Multiplexing Access (OFDMA) is applied for downlink, and Single Carrier Frequency Division Multiple Access (SC-FDMA) is applied for uplink.

[0041] A radio frame is configured with 10 subframes arranged in a time direction as illustrated in Fig. 5. Each subframe is configured with two slots arranged in the time direction. A length of each subframe is 1 ms, and a length of each slot is 0.5 ms. Each subframe includes a plurality of resource blocks (RBs) in a frequency direction and includes a plurality of symbols in the time direction. Each resource block includes a plurality of sub carriers in the frequency direction. One resource element (RE) is configured with one symbol and one sub carrier. Among radio resources (time and frequency resources) allocated to the UE 100, the frequency resources can be specified by resource blocks, and the time resources can be specified by subframes (or slots).

[0042] In the downlink, an interval of several symbols at the head of each subframe is a control region used as a 25 physical downlink control channel (PDCCH) for transmitting control information mainly. The remaining interval of each subframe is a data region that can be used as a physical downlink shared channel (PDSCH) for transmitting user data mainly.

[0043] The eNB 200 transmits information (L1/L2 control information) for notifying of downlink and uplink resource 30 allocation results to the UE 100 through the PDCCH. Each PDCCH occupies resources configured with one or more control channel elements (CCEs). One CCE is configured with a plurality of REs. One of 1, 2, 4, and 8 is set as the number of CCEs occupied by the PDCCH (an aggregation level).

[0044] The eNB 200 transmits a plurality of pieces of control information. The eNB 200 includes CRC bit scrambled using an identifier (Radio Network Temporary ID (RNTI)) of the UE 100 of a transmission destination in control information in order to identify the UE 100 of the transmission destination of each control information.

[0045] For a plurality of pieces of control information that may be directed to its own UE, each of the UEs 100 performs descrambling on the CRC bits using the RNTI of its own UE, performs blind decoding on the PDCCH, and detects the control information directed to its own UE.

[0046] In order to reduce the number of blind decodings, a CCE serving as a blind decoding target is limited. A CCE region serving as the blind decoding target is referred to as "search space." The search space will be described later in 40 detail.

## (2) Operation according to first embodiment

[0047] The LTE system according to the first embodiment supports group communication. An operation for appropriately controlling the group communication according to the first embodiment will be described below.

### (2.1) Operation overview

[0048] Figs. 6(a) and 6(b) are diagrams for describing an operation according to the first embodiment. Fig. 6(a) illustrates 50 a downlink subframe according to the first embodiment, and Fig. 6(b) illustrates an operation environment according to the first embodiment.

[0049] As illustrated in Figs. 6(a) and 6(b), the LTE system according to the first embodiment includes an eNB 200 that manages a cell and transmits control information in a control region (a PDCCH region) in a downlink subframe and a plurality of UEs 100 that constitute a terminal group (hereinafter, referred to simply as a "group") that perform the group communication in the cell. Each group is identified by a service identifier (hereinafter, referred to as a "GC service ID"). Figs. 6(a) and 6(b) illustrate an example in which UEs 100-1 to 100-3 belong to a group A, and UEs 100-4 to 100-6 belong to a group B.

[0050] Each of the UEs 100 is in the RRC connected state, and a different identifier (cell RNTI (C-RNTI)) is allocated

from the eNB 200 to each UE 100 in the cell.

[0051] A group communication identifier (a group communication RNTI (GC-RNTI)) is allocated to each of the UEs 100 that perform the group communication. In the first embodiment, a different GC-RNTI is allocated to each of the UEs 100 for each group. In Figs. 6(a) and 6(b), a GC-RNTI(A) is allocated to the UEs 100-1 to 100-3 belonging to the group A, and a GC-RNTI(B) is allocated to the UEs 100-4 to 100-6 belonging to the group B. An operation of allocating the GC-RNTI will be described later.

[0052] The PDCCH region includes a common search space (CSS) in which control information common to all the UEs 100 in the cell is arranged and a UE specific search space (USS) in which control information specific to each of the UEs 100 in the cell is arranged. The control information common to all the UEs 100 in the cell is, for example, allocation information related to a broadcast signal and a paging signal. The control information specific to each of the UEs 100 in the cell is, for example, allocation information related to downlink user data. The USS is set according to the C-RNIT, a subframe number, and the like.

[0053] In the first embodiment, the PDCCH region further includes a group communication search space (GCSS) in which group communication control information related to the group communication (hereinafter, referred to as "GC control information") is arranged. The GC control information is, for example, allocation information (information of an allocation resource block) related to downlink user data (group communication data). The GC control information may include information of the MCS. When semi-persistent scheduling is performed, information indicating a duration of an allocation resource block may be included. The GCSS is set according to the GC-RNTI, the subframe number, and the like. In the first embodiment, since the GC-RNTI differs according to each group, the GCSS differs according to each group as well. In Figs. 6(a) and 6(b), the GCSS corresponding to the group A and the GCSS corresponding to the group B are individually set.

[0054] Hereinafter, a region in which the CSS is set in the PDCCH region is referred to as a "CSS region," a region in which the USS is set is referred to as a "USS region," and a region in which the GCSS is set is referred to as a "GCSS region."

[0055] The eNB 200 arranges the GC control information in the GCSS region according to the GC-RNTI. Specifically, the eNB 200 performs mapping of the GC control information for the group A in the GCSS corresponding to the group A, and performs mapping of the GC control information for the group B in the GCSS corresponding to the group B. The eNB 200 scrambles the GC control information for the group A using the GC-RNTI(A) allocated to the group A, and scrambles the GC control information for the group B using the GC-RNTI(B) allocated to the group B.

[0056] Each of the UEs 100 acquires the GC control information arranged in the GCSS according to the GC-RNTI allocated to its own UE 100. Specifically, each of the UEs 100 performs blind decoding (monitoring) of the GCSS corresponding to the group to which its own UE 100 belongs using the GC-RNTI allocated to its own UE 100. Then, each of the UEs 100 acquires the GC control information for the group to which its own UE 100 belongs through the blind decoding. For example, the UE 100-1 acquires the GC control information for the group A through the blind decoding of the GCSS corresponding to the group A. On the other hand, the UE 100-4 acquires the GC control information for the group B through the blind decoding of the GCSS corresponding to the group B.

[0057] As described above, in the first embodiment, since the GC-RNTI differs according to each group, the GC control information is transmitted within the PDCCH region. As a result, for example, a flexible (dynamic) radio resource allocation can be performed according to the number of groups, the group communication data amount, and the like for each group.

## (2.2) GC-RNTI allocation operation

[0058] Next, a GC-RNTI allocation operation according to the first embodiment will be described.

### (2.2.1) First operation pattern

[0059] In the first operation pattern, the eNB 200 or the core network (the EPC 20) decides the GC-RNTI according to a request from the UE 100 that attempts to start the group communication. The eNB 200 notifies the UE 100 of the request source of the decided GC-RNTI. For example, the eNB 200 transmits the GC-RNTI through an individual RRC message in the unicast manner. In this case, the GC-RNTI may be included in group communication setting information (Configuration).

[0060] Fig. 7 is a sequence diagram illustrating an operation when the eNB 200 allocates the GC-RNTI.

[0061] As illustrated in Fig. 7, in step S11, the UE 100 establishes an RRC connection with the eNB 200.

[0062] Thereafter, the UE 100 performs a group communication initiation process. In step S12, the UE 100 transmits a GC-RNTI allocation request (a GC control request) to the eNB 200. The GC control request includes the GC service ID of the group communication that the UE 100 desires to join.

[0063] In step S13, the eNB 200 that has received the GC control request derives the GCRNTI from the GC service ID included in the GC control request. The eNB 200 is assumed to receive a GC service ID list from the EPC 20 and

associate the GC-RNTI with each group communication. For example, an association timing is a timing at which the GC service ID list is received from the EPC 20 or a timing at which the GC control request is received from the UE 100.

[0064] In step S14, the eNB 200 transmits a response (a GC control response) including the GC-RNTI corresponding to the GC service ID to the UE 100.

5 [0065] The UE 100 acquires and holds the GC-RNTI included in the GC control response. The UE 100 starts the blind decoding as the GC-RNTI is held.

[0066] Fig. 8 is a sequence diagram illustrating an operation when the EPC 20 allocates the GC-RNTI. When the EPC 20 allocates the GC-RNTI, a plurality of eNBs 200 can operate in collaboration with one another. Here, an example in which an MME 300 in the EPC 20 allocates the GC-RNTI is illustrated.

10 [0067] As illustrated in Fig. 8, in step S21, the UE 100 establishes an RRC connection with the eNB 200.

[0068] Thereafter, the UE 100 performs a group communication initiation process. In step S22, the UE 100 transmits the GC-RNTI allocation request (the GC control request) to the eNB 200. The GC control request includes the GC service ID of the group communication that the UE 100 desires to join.

15 [0069] When the eNB 200 holds an association between the GC service ID and the GC-RNTI, the eNB 200 may allocates the GC-RNTI based on the association. Here, the eNB 200 is assumed not to hold the association. In step S23, the eNB 200 transfers the GC control request transmitted from the UE 100 to the MME 300.

[0070] In step S24, the MME 300 that has received the GC control request derives the GCRNTI from the GC service ID included in the GC control request.

20 [0071] In step S25, the MME 300 transmits a response (the GC control response) including the GC-RNTI corresponding to the GC service ID to the eNB 200.

[0072] In step S26, the eNB 200 that has received the GC control response transfers the GC control response to the UE 100. Further, when the GC-RNTI allocated by the MME 300 is identical to an RNTI allocated by its own eNB 200, the eNB 200 may request the MME 300 to change the allocation of the GC-RNTI.

25 [0073] The UE 100 acquires and holds the GC-RNTI included in the GC control response. The UE 100 starts the blind decoding as the GC-RNTI is held.

#### (2.2.2) Second operation pattern

[0074] In the first operation pattern, the eNB 200 notifies the UE 100 of the GC-RNTI in the unicast manner but may notify of the GC-RNTI in the broadcast manner.

[0075] In the second operation pattern, the eNB 200 transmits a message including a plurality of GC service IDs that differ according to each group and a plurality of GC-RNTIs corresponding to the plurality of GC service IDs within the cell in the broadcast manner. This message may be a common RRC message (for example, a system information block).

[0076] In the second operation pattern, the UE 100 that has received the message acquire the GC-RNTI corresponding to the GC service ID of the group communication that it desires to join from the message and holds the GC-RNTI. The UE 100 starts the blind decoding as the GC-RNTI is held.

#### (2.2.3) Range of GC-RNTI

40 [0077] Table 1 illustrates available RNTIs in the current specification and ranges of values thereof.

[Table 1]

Value (hexa-decimal)	RNTI
0000	N/A
0001-003C	RA-RNTI, C-RNTI, Semi-Persistent Scheduling C-RNTI, Temporary C-RNTI, TPC-PUCCH-RNTI and TPC-PUSCH-RNTI (see note)
003D-FFF3	C-RNTI, Semi-Persistent Scheduling C-RNTI, Temporary C-RNTI, TPC-PUCCH-RNTI and TPC-PUSCH-RNTI
FFF4-FFFC	Reserved for future use
FFFD	M-RNTI
FFFE	P-RNTI
FFFF	SI-RNTI

[0078] As shown in Table 1, an RNTI value has a range of 0000-FFFF. A "FFF4-FFFC" region reserved for the future

use may be used as the range of the GC-RNTI value. Alternatively, a part of a "0001-003C" or "003D-FFF3" region may be allocated for the group communication. Alternatively, when a "0001-003C" or "003D-FFF3" region is used, it may be dynamically used, or a part may be cut for the GC-RNTI in advance.

5 (2.3) Group communication operation

**[0079]** Next, a group communication operation according to the first embodiment will be described. As described above, the eNB 200 allocates downlink radio resources for the group communication using, the GC-RNTI.

**[0080]** Fig. 9 is a sequence diagram illustrating a group communication operation according to the first embodiment. 10 In Fig. 9, the UEs 100-1 to 100-3 are assumed to belong to the same group (the group A), and the GC-RNTI is assumed to have been allocated. The eNB 200 starts to allocate the downlink radio resources for the group communication according to a group communication delivery request transmitted from the EPC 20.

**[0081]** As illustrated in Fig. 9, in step S31, the eNB 200 performs mapping of the GC control information for the group A in the GCSS corresponding to the group A, and scrambles the GC control information for the group A using the GC-RNTI allocated to the group A. As described above, the GC control information is, for example, the allocation information (the information of the allocation resource block) related to the group communication data. The GC control information may include information of the MCS.

**[0082]** In step S32, the eNB 200 transmits the GC control information and the group communication data. When the dynamic resource allocation (dynamic scheduling) is performed, the group communication data is arranged in a resource block in a data region of a downlink subframe in which the GC control information is arranged. However, the eNB 200 may perform a semi-persistent resource allocation (semi-persistent scheduling).

**[0083]** In step S33, each of the UEs 100 acquires the GC control information arranged in the GCSS corresponding to the group A according to the GC-RNTI allocated to its own UE 100. Specifically, each of the UEs 100 performs the blind decoding (monitoring) of the GCSS corresponding to the group to which its own UE 100 belongs using the GC-RNTI allocated to its own UE 100. Each of the UEs 100 acquires the GC control information for the group to which its own UE 100 belongs through the blind decoding.

**[0084]** In step S34, each of the UEs 100 receives the group communication data based on the acquired GC control information. Specifically, each of the UEs 100 demodulates and decodes the group communication data arranged in the resource block indicated by the GC control information.

30 (3) Conclusion of first embodiment

**[0085]** In the first embodiment, the eNB 200 arranges the GC control information in the GCSS region according to the GC-RNTI. Each of the UEs 100 acquires the GC control information arranged in the GCSS according to the GC-RNTI allocated to its own UE 100. As a result, the dynamic scheduling in the group communication can be implemented.

**[0086]** Further, it is possible to collectively allocate the resource blocks to a plurality of UEs 100 belonging to one group and collectively transmit (that is, multicast) the group communication data to a plurality of UEs 100 through the resource blocks. Thus, the radio resources can be efficiently used.

40 [First modified example of first embodiment]

**[0087]** The first embodiment has been described in connection with the example in which the GC-RNTI differs according to each group. In this case, it is necessary to secure a plurality of GC-RNTIs and a plurality of GCSSs, and resources are likely to be tight. Thus, one GC-RNTI may be shared by the respective groups instead of causing the GC-RNTI to differ according to each group.

**[0088]** In the first modified example of the first embodiment, the GC-RNTI is a fixed value that is specified on a system in advance. Thus, the GC-RNTI is common to all groups. In this case, the GC control information includes information for receiving radio resources included in the data region other than the PDCCH region in the downlink subframe. This information includes the information of the allocation resource block, the information of the MCS, and the like. When the semi-persistent scheduling is performed, information indicating the duration of the allocation resource block may be further included.

**[0089]** In the first modified example of the first embodiment, the user data or the control information is arranged in the radio resources indicated by the GC control information together with the GC service ID. In other words, the GC control information is common to the respective groups and cut for each group based on the GC service ID in the data region.

**[0090]** Figs. 10(a) and 10(b) are diagrams illustrating a first operation pattern according to the first modified example of the first embodiment. In the first operation pattern, the user data is arranged in the radio resources indicated by the GC control information together with the GC service ID.

**[0091]** As illustrated in Figs. 10(a) and 10(b), the eNB 200 arranges the GC control information in the GCSS region

according to the GC-RNTI. The GC-RNTI is common to the groups A and B, and thus the GCSS is also common to the groups A and B. The eNB 200 scrambles the GC control information using the GC-RNTI.

[0092] The eNB 200 allocates the radio resources in the data region to the UEs 100 belonging to the groups A and B. In the first operation pattern, the eNB 200 arranges the GC service ID of the group A, the GC service ID of the group B, the group communication data of the group A, and the group communication data of the group B in the radio resources. Here, the group communication data of the group A is associated with the GC service ID of the group A. The group communication data of the group B is associated with the GC service ID of the group B. For example, a corresponding GC service ID is added to the head of the group communication data.

[0093] The UE 100 acquires the GC control information in the GCSS using the GC-RNIT allocated to its own UE 100. The UE 100 specifies allocation radio resources in the data region based on the GC control information, acquires the GC service ID included in the specified radio resources, and detects the GC service ID corresponding to the group communication in which its own UE 100 is taking part. Then, the UE 100 acquires the group communication data associated with the detected GC service ID.

[0094] Figs. 11(a) and 11(b) are diagrams illustrating a second operation pattern according to the first modified example of the first embodiment. In the second operation pattern, the control information is arranged in the radio resources indicated by the GC control information together with the GC service ID.

[0095] As illustrated in Figs. 11(a) and 11(b), the eNB 200 arranges the GC control information in the GCSS region according to the GC-RNTI. The GC-RNTI is common to the groups A and B, and thus the GCSS is also common to the groups A and B. The eNB 200 scrambles the GC control information using the GC-RNTI.

[0096] In the second operation pattern, the eNB 200 allocates radio resources in which the control information is arranged, radio resources in which the group communication data of the group A is arranged, and radio resources in which the group communication data of the group B is arranged in the data region.

[0097] The eNB 200 arranges control information (A) including the GC service ID of the group A and control information (B) including the GC service ID of the group B in the radio resources in which the control information is arranged. The control information (A) is scheduling information related to the radio resources in which the group communication data of the group A is arranged. The control information (B) is scheduling information related to the radio resources in which the group communication data of the group B is arranged. The control information (A) and (B) may include the information of the MCS. Further, when the semi-persistent scheduling is performed, the control information (A) and (B) may further include information the duration of the allocation resource block.

[0098] The UE 100 acquires the GC control information in the GCSS using the GC-RNIT allocated to its own UE 100. The UE 100 specifies the radio resources in the data region based on the GC control information, and acquires the control information included in the specified radio resources. Here, the UE 100 detects the control information including the GC service ID corresponding to the group communication in which its own UE 100 is taking part. Then, the UE 100 specifies the radio resources indicated by the detected control information, and acquires the group communication data included in the specified radio resources.

[Second modified example of first embodiment]

[0099] In the second modified example of the first embodiment, an example in which the UE 100 that performs the group communication performs a discontinuous reception (DRX) operation is assumed. The UE 100 that performs the DRX operation monitors control information in a first ON period in which control information different from the GC control information is received, and monitors the GC control information in a second ON period in which the GC control information is received.

[0100] Figs. 12(a) to 12(c) are timing charts illustrating an operation according to the second modified example of the first embodiment.

[0101] As illustrated in Fig. 12(a), the UE 100 that performs the DRX operation monitors the control information different from the GC control information such as the control information transmitted using the C-RNTI in an ON period of a DRX cycle. Specifically, the receiver (the radio transceiver 110) is turned at intervals of the DRX cycles, and the blind decoding of the PDCCH region is performed using the C-RNTI.

[0102] Here, when the group communication is allocated discontinuously (periodically), the UE 100 needs to turn on the receiver in the ON period in which the GC control information is received as well as the ON period illustrated in Fig. 12(a) as illustrated in Fig. 12(b). Thus, as illustrated in Fig. 12(c), the UE 100 performs control the receiver is turned on in the ON period illustrated in Fig. 12(a) and the ON period illustrated in Fig. 12(b).

[Second embodiment]

[0103] A second embodiment will be described focusing on a difference with the first embodiment. A system configuration according to the second embodiment is the same as in the first embodiment.

[0104] In the first embodiment, the GC control information is arranged in the GCSS region. On the other hand, in the second embodiment, the GC control information is arranged in the CSS region without disposing the GCSS region.

[0105] Figs. 13(a) and 13(b) are diagrams for describing an operation according to the second embodiment.

[0106] As illustrated in Figs. 13(a) and 13(b), the eNB 200 arranges the GC control information related to the group communication in the CSS according to the GC-RNTI allocated to each group. Here, the eNB 200 scrambles the GC control information using the GC-RNTI.

[0107] Specifically, the eNB 200 performs mapping of the GC control information for the group A in the CSS corresponding to the group A, and performs mapping of the GC control information for the group B in the CSS corresponding to the group B. The eNB 200 scrambles the GC control information for the group A using the GC-RNTI(A) allocated to the group A, and scrambles the GC control information for the group B using the GC-RNTI(B) allocated to the group B.

[0108] The eNB 200 also arranges the control information common to all the UEs 100 in the cell in the CSS. The eNB 200 scrambles the common control information, for example, using an SI-RNTI and/or a P-RNTI.

[0109] Each of the UEs 100 acquires the GC control information arranged in the CSS according to the GC-RNTI allocated to its own UE 100. Specifically, each of the UEs 100 performs the blind decoding (monitoring) of the GCSS corresponding to the group to which its own UE 100 belongs using the GC-RNTI allocated to its own UE 100. Then, each of the UEs 100 acquires the GC control information for the group to which its own UE 100 belongs through the blind decoding.

[0110] The remaining points are similar to those in the first embodiment. Specifically, in the second embodiment, the GC-RNTI differs according to each group in which the group communication is performed in the cell.

[0111] The eNB 200 or the core network decides the GC-RNTI according to the request of the UE 100 that desires to start the group communication. The eNB 200 notifies the UE 100 of the request source of the decided GC-RNTI.

[0112] Alternatively, the eNB 200 transmits a message including a plurality of GC service IDs that differ according to each group and a plurality of GC-RNTIs corresponding to the plurality of GC service IDs within the cell in the broadcast manner.

[Modified example of second embodiment]

[0113] The second embodiment has been described in connection with the example in which the GC-RNTI differs according to each group. However, similarly to the first modified example of the first embodiment, one GC-RNTI may be shared by the respective groups.

[Third embodiment]

[0114] A third embodiment will be described focusing on a difference with the first embodiment. A system configuration according to the second embodiment is the same as in the first embodiment.

[0115] In the first embodiment, the GC control information is arranged in the GCSS region. On the other hand, in the third embodiment, the GC control information is arranged in the USS region without disposing the GCSS region.

[0116] Figs. 14(a) and 14(b) are diagrams for describing an operation according to the third embodiment.

[0117] As illustrated in Figs. 14(a) and 14(b), the eNB 200 arranges the GC control information related to the group communication in the USS according to the GC-RNTI allocated to each group. Here, the eNB 200 scrambles the GC control information using the GC-RNTI.

[0118] Specifically, the eNB 200 performs mapping of the GC control information for the group A in the USS corresponding to the group A, and performs mapping of the GC control information for the group B in the USS corresponding to the group B. The eNB 200 scrambles the GC control information for the group A using the GC-RNTI(A) allocated to the group A, and scrambles the GC control information for the group B using the GC-RNTI(B) allocated to the group B.

[0119] Each of the UEs 100 acquires the GC control information arranged in the USS according to the GC-RNTI allocated to its own UE 100. Specifically, each of the UEs 100 performs the blind decoding (monitoring) of the GUSS corresponding to the group to which its own UE 100 belongs using the GC-RNTI allocated to its own UE 100. Then, each of the UEs 100 acquires the GC control information for the group to which its own UE 100 belongs through the blind decoding.

[0120] The remaining points are similar to those in the first embodiment. Specifically, in the third embodiment, the GC-RNTI differs according to each group in which the group communication is performed in the cell.

[0121] The eNB 200 or the core network decides the GC-RNTI according to the request of the UE 100 that desires to start the group communication. The eNB 200 notifies the UE 100 of the request source of the decided GC-RNTI.

[0122] Alternatively, the eNB 200 transmits a message including a plurality of GC service IDs that differ according to each group and a plurality of GC-RNTIs corresponding to the plurality of GC service IDs within the cell in the broadcast manner.

[First modified example of third embodiment]

5 [0123] The third embodiment has been described in connection with the example in which the GC-RNTI differs according to each group. However, similarly to the first modified example of the first embodiment, one GC-RNTI may be shared by the respective groups.

[Second modified example of third embodiment]

10 [0124] In the third embodiment, similarly to the second modified example of the first embodiment, the UE 100 that performs the DRX operation monitors control information in the first ON period in which control information different from the GC control information is received, and monitors the GC control information in the second ON period in which the GC control information is received.

15 [Other embodiments]

[0125] The above embodiments have been described in connection with the example in which each of the UEs 100 belongs to one group, but one UE 100 may belong to a plurality of groups. In this case, one UE 100 may hold a plurality of GC-RNTIs.

20 [0126] In the above embodiments, the LTE system has been described as an example of the mobile communication system, but the present invention is not limited to the LTE system and may be applied to any other system than the LTE system.

[0127] The entire contents of Japanese Priority Patent Application No. 2014-058040 (March 20, 2014) are incorporated herein by reference.

## 25 INDUSTRIAL APPLICABILITY

[0128] The present invention is useful in a radio communication field such as mobile communication.

[0129] The following examples listed below are directed to advantageous embodiments which may represent separate and independent inventions.

### 30 A. A mobile communication system, comprising:

35 a base station configured to manage a cell and transmit control information in a control region in a downlink subframe;  
 a plurality of user terminals configured to constitute a terminal group in which group communication is performed in the cell,  
 wherein the base station arranges group communication control information related to the group communication in a predetermined search space included in the control region according to a group communication identifier allocated to be common to the plurality of user terminals, and  
 40 each of the plurality of user terminals acquires the group communication control information according to the group communication identifier allocated to its own user terminal.

### 45 B. The mobile communication system according to embodiment A,

wherein the group communication identifier differs according to each terminal group.

### 50 C. The mobile communication system according to embodiment A,

wherein the group communication identifier is decided by the base station or a core network according to a request of a user terminal that desires to start the group communication, and  
 the base station notifies the user terminal of the request source of the decided group communication identifier.

### 55 D. The mobile communication system according to embodiment A,

wherein the base station transmits a message including a plurality of service identifiers that differ according to each terminal group and a plurality of group communication identifiers corresponding to the plurality of service identifiers in the cell in a broadcast manner.

### E. The mobile communication system according to embodiment A,

wherein the group communication identifier is a fixed value specified on a system in advance,

the group communication control information includes information for receiving radio resources included in a data

region other than the control region, and  
user data or the control information is arranged in the radio resources together with a service identifier that differs according to each terminal group.

5 F. The mobile communication system according to embodiment A,  
wherein a user terminal that performs discontinuous reception (DRX) operation among the plurality of user terminals monitors control information different from the group communication control information in a first ON period, and monitors the group communication control information in a second ON period.

10 G. The mobile communication system according to embodiment A,  
wherein the predetermined search space is a group communication search space in which the group communication control information related to the group communication is arranged.

15 H. The mobile communication system according to embodiment A,  
wherein the predetermined search space is a common search space in which control information common to all the user terminals in the cell is arranged.

20 I. The mobile communication system according to embodiment A,  
wherein the predetermined search space is a specific search space in which control information specific to each of the user terminals in the cell is arranged.

J. A base station, comprising:

25 a controller configured to manage a cell in which a plurality of user terminals constituting a terminal group performing group communication exist,  
wherein the controller transmits control information in a control region in a downlink subframe, and  
the controller arranges group communication control information related to the group communication in a pre-determined search space included in the control region according to a group communication identifier allocated to be common to the plurality of user terminals.

30 K. A user terminal, comprising:

35 a controller configured to perform group communication in a cell managed by a base station that transmits control information in a control region in a downlink subframe,  
wherein the controller acquires group communication control information related to the group communication arranged in a predetermined search space included in the control region according to a group communication identifier allocated to its own user terminal.

## 40 Claims

1. A user equipment for communicating with a base station, **characterized by** comprising  
a controller configured to execute a process of receiving a PDCCH from the base station by using a fixed RNTI predefined in a system,  
45 wherein the PDCCH includes information indicating an allocation of a PDSCH,  
the PDSCH includes a service identifier and scheduling information corresponding to the service identifier, and  
the controller is configured to receive the service identifier and the scheduling information based on the PDCCH received using the fixed RNTI.
2. A base station for communicating with a user equipment, **characterized by** comprising  
a controller configured to execute a process of transmitting a PDCCH by using a fixed RNTI predefined in a system,  
wherein the PDCCH includes information indicating an allocation of a PDSCH, and  
the controller is configured to include, into the PDSCH, a service identifier and scheduling information corresponding to the service identifier.
3. A method performed at a user equipment for communicating with a base station, **characterized by** comprising  
receiving a PDCCH from the base station by using a fixed RNTI predefined in a system, wherein the PDCCH includes information indicating an allocation of a PDSCH, and the PDSCH includes a service identifier and scheduling information

mation corresponding to the service identifier; and  
receiving the service identifier and the scheduling information based on the PDCCH received using the fixed RNTI.

5       4. A method performed at a base station for communicating with a user equipment, **characterized by** comprising  
transmitting a PDCCH by using a fixed RNTI predefined in a system, wherein the PDCCH includes information  
indicating an allocation of a PDSCH; and  
including, into the PDSCH, a service identifier and scheduling information corresponding to the service identifier.

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FIG. 1

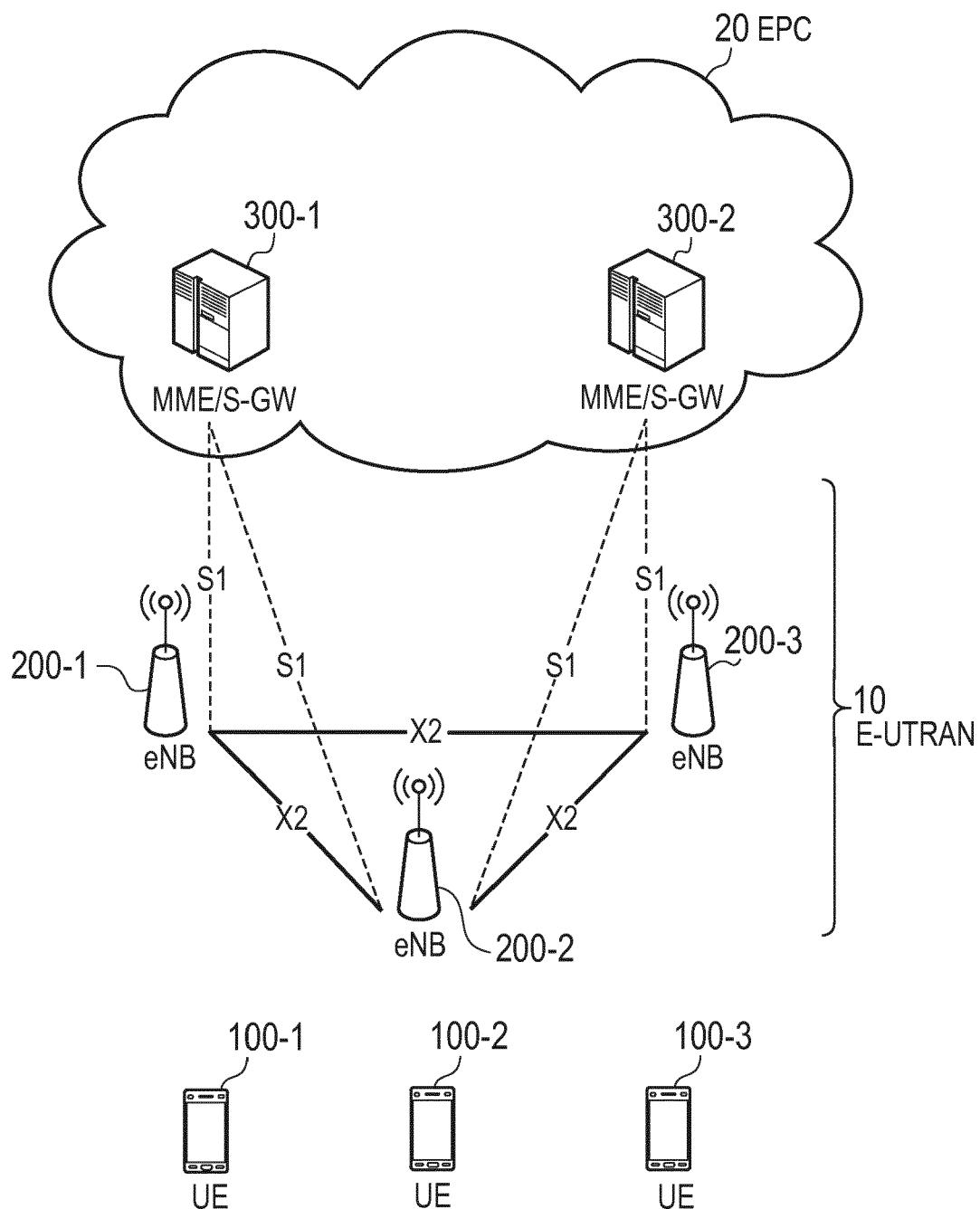


FIG. 2

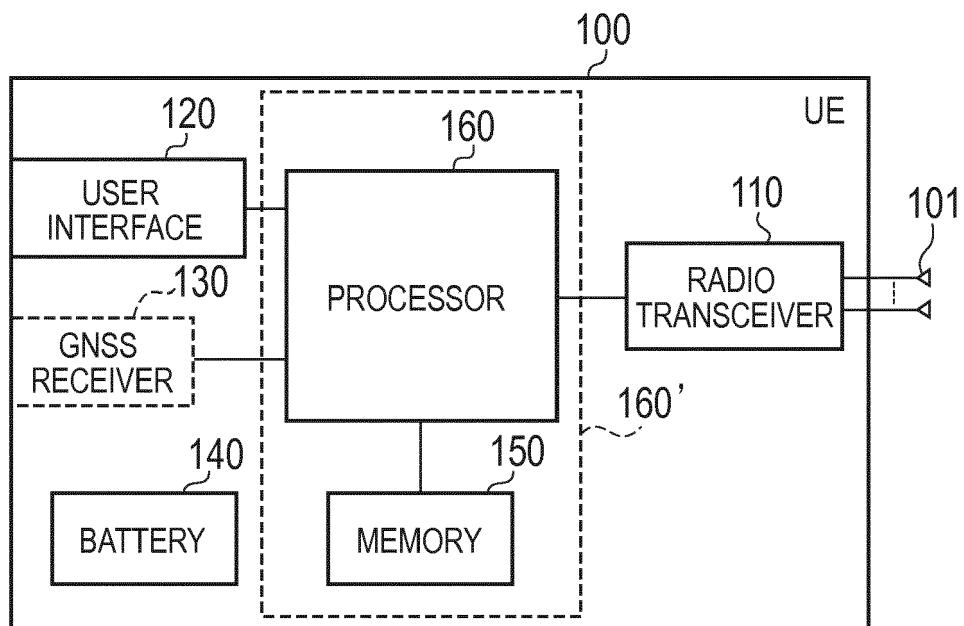


FIG. 3

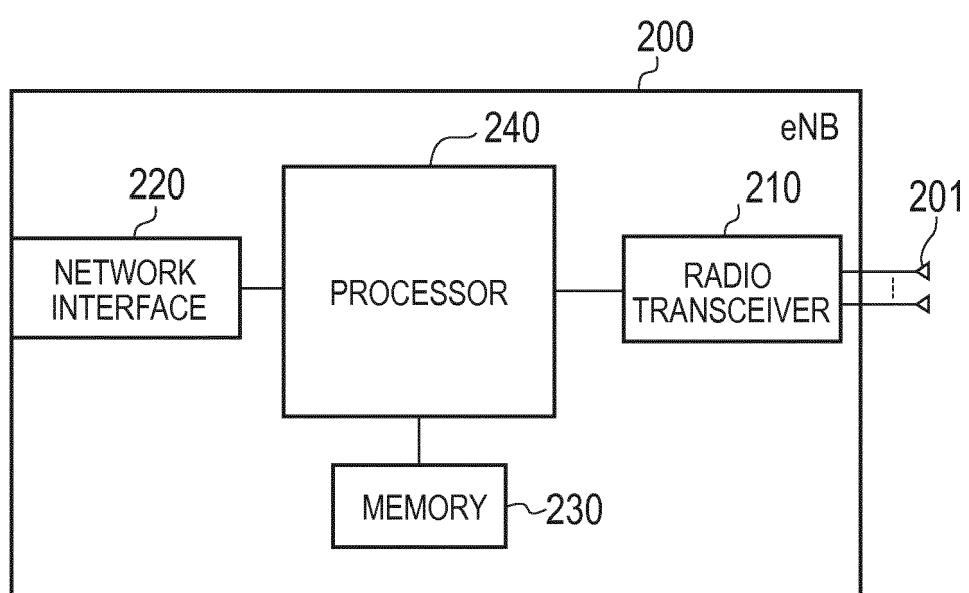


FIG. 4

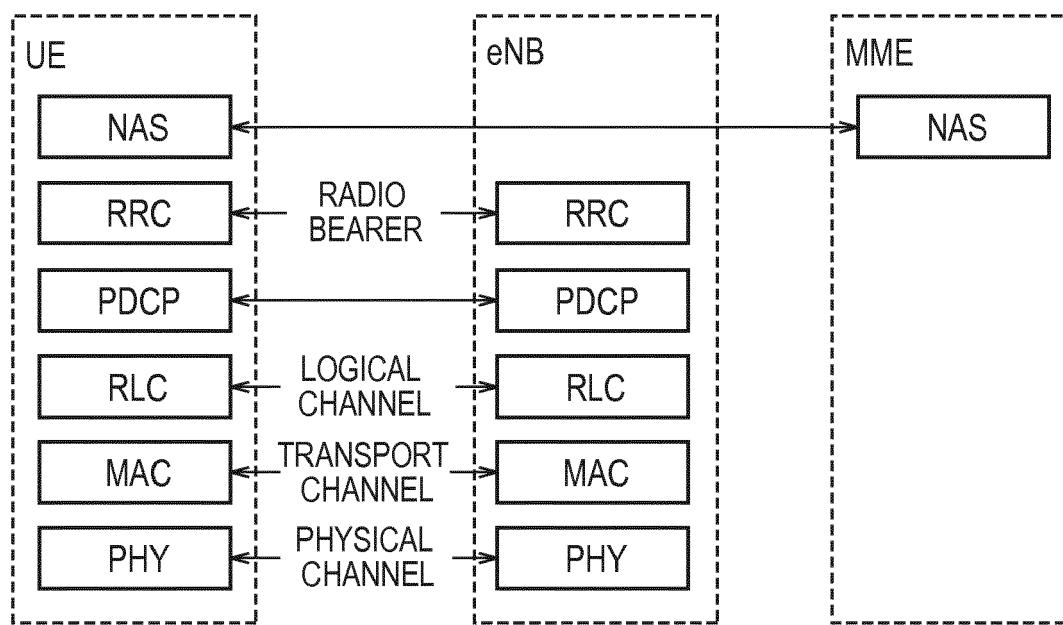


FIG. 5

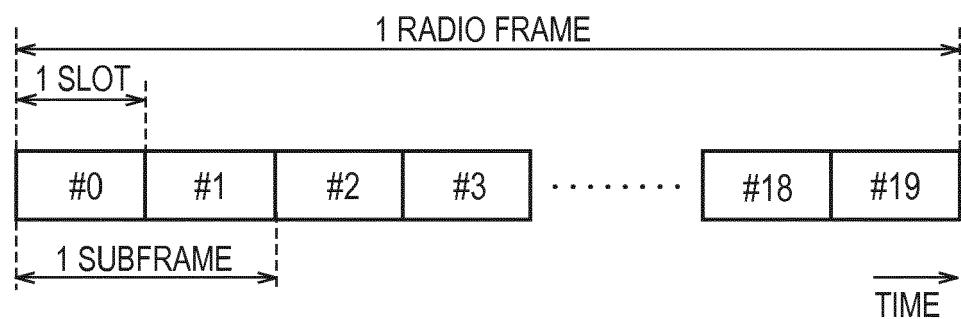


FIG. 6

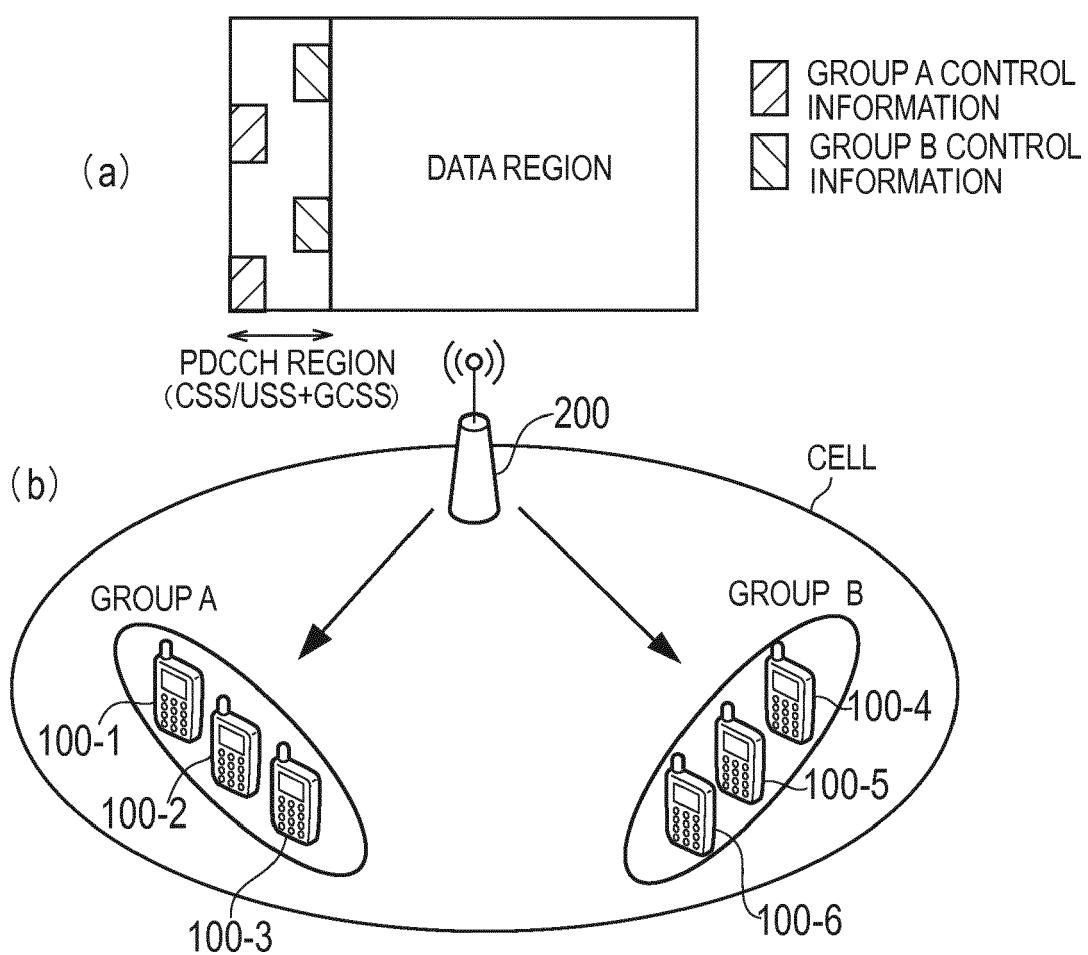


FIG. 7

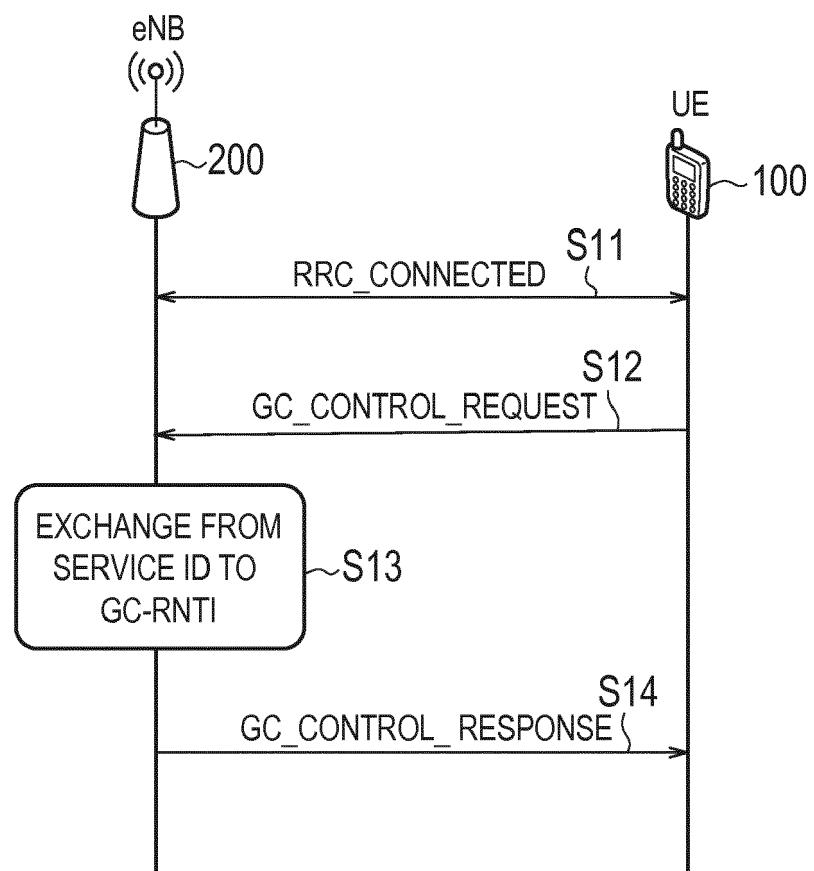


FIG. 8

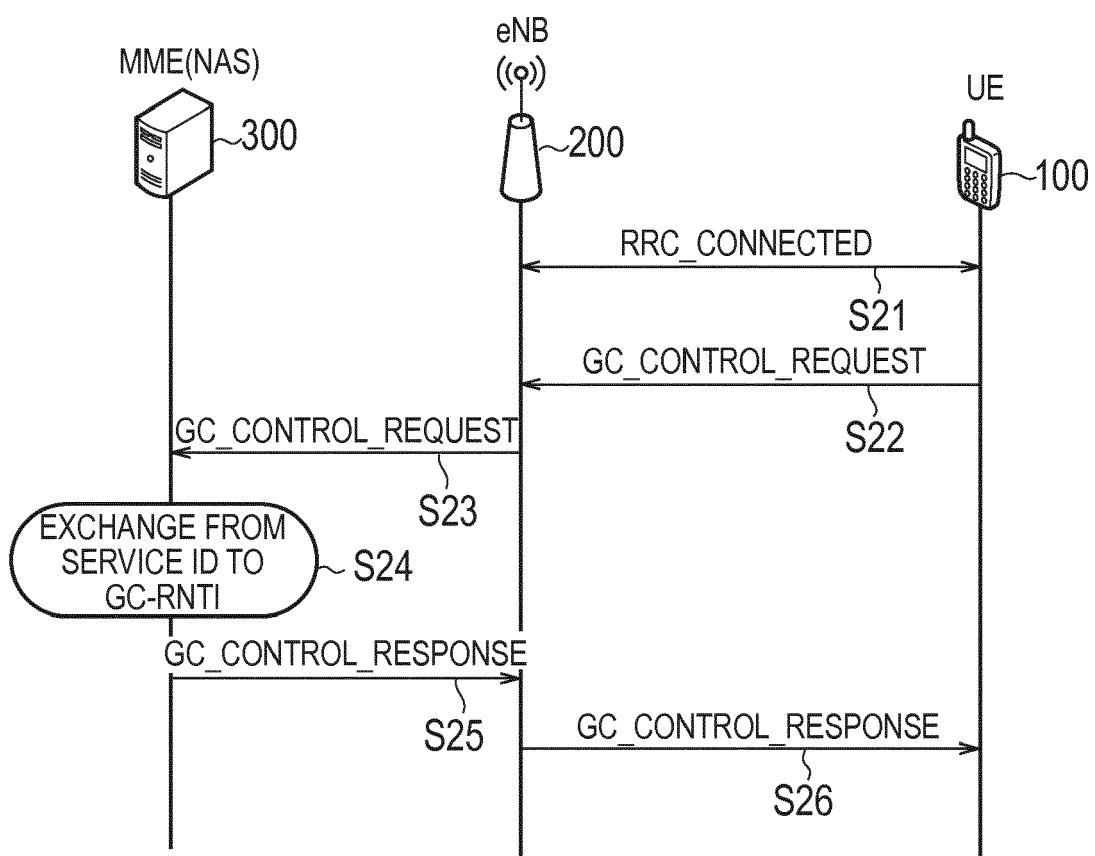


FIG. 9

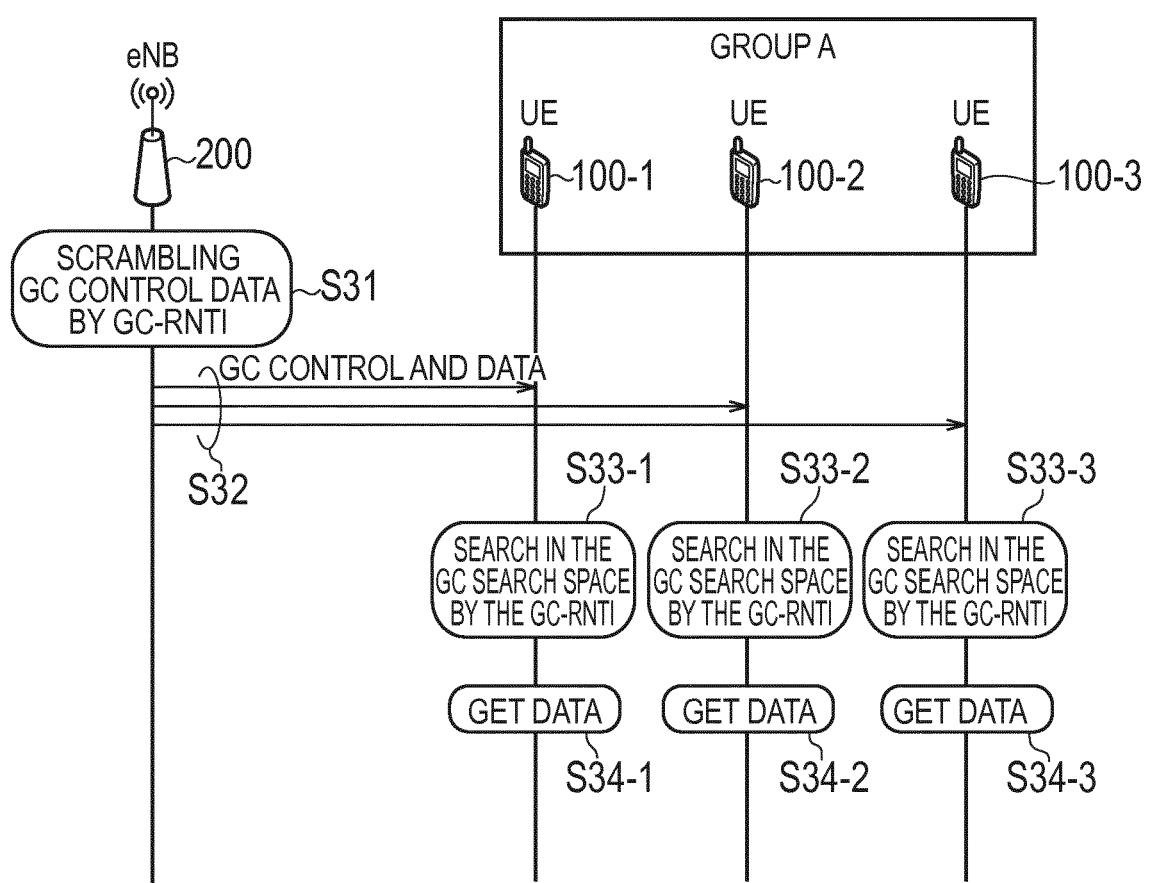


FIG. 10

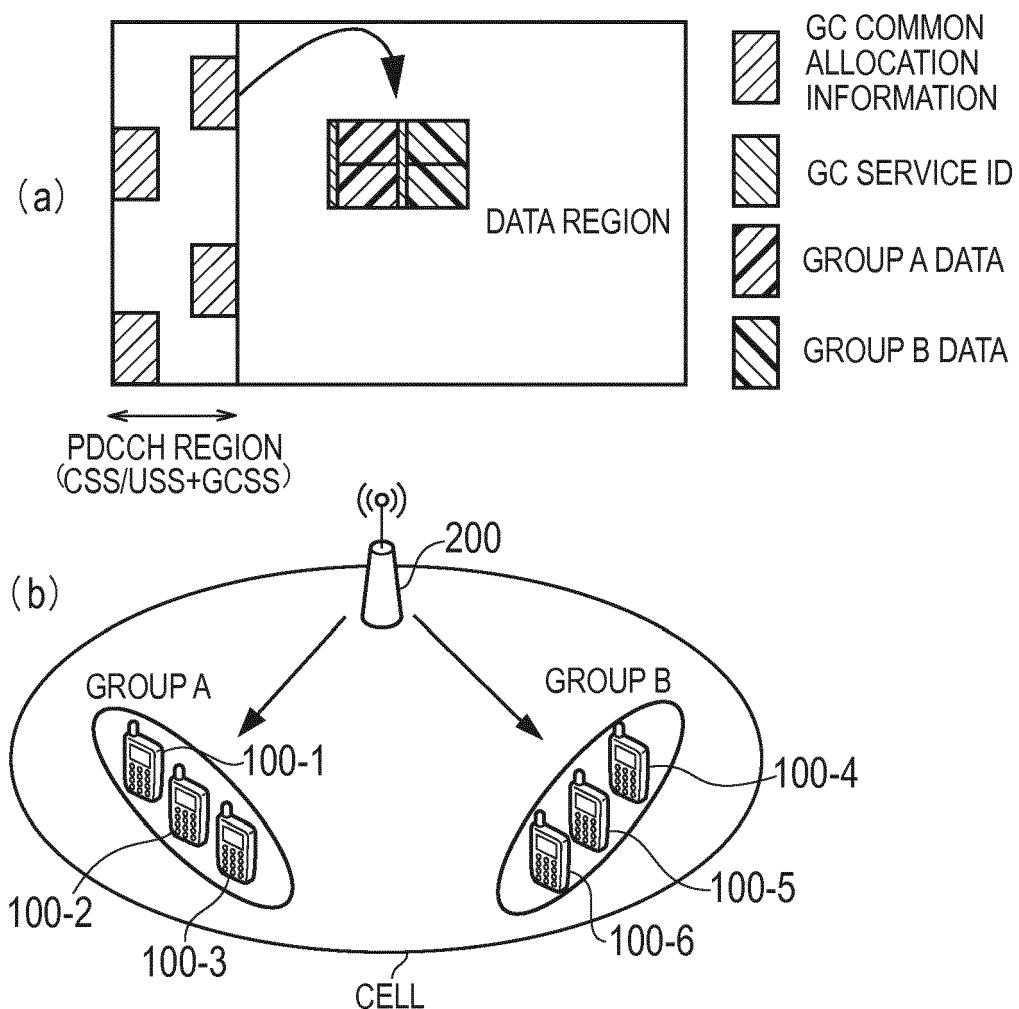


FIG. 11

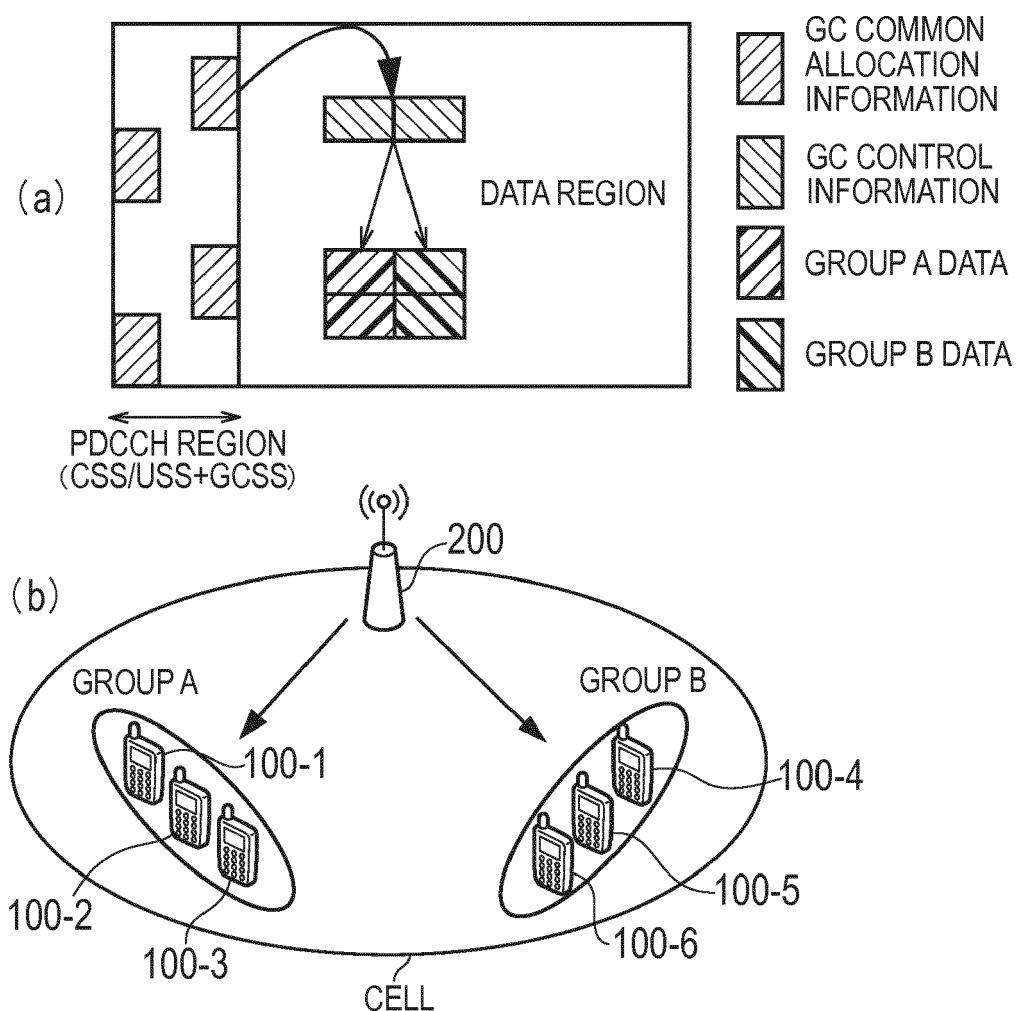


FIG. 12

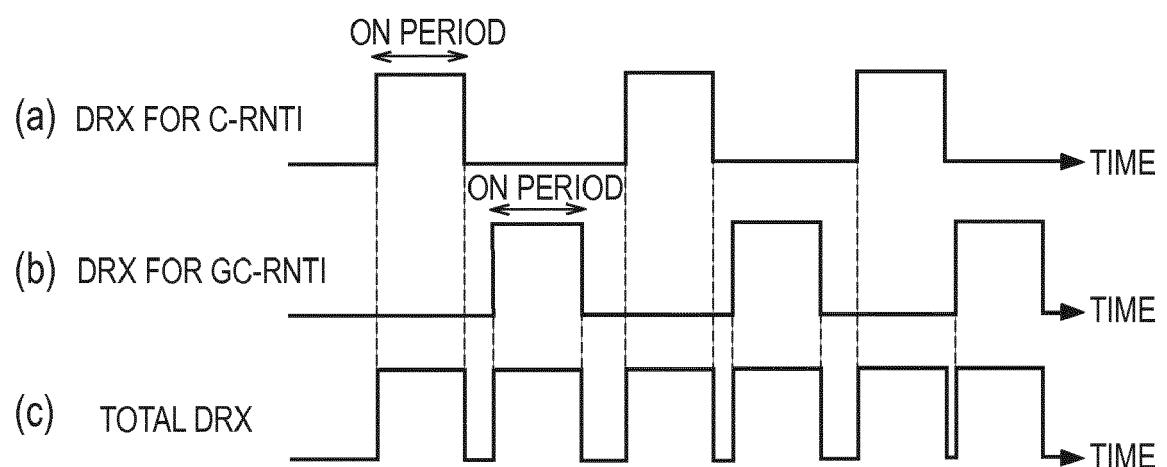


FIG. 13

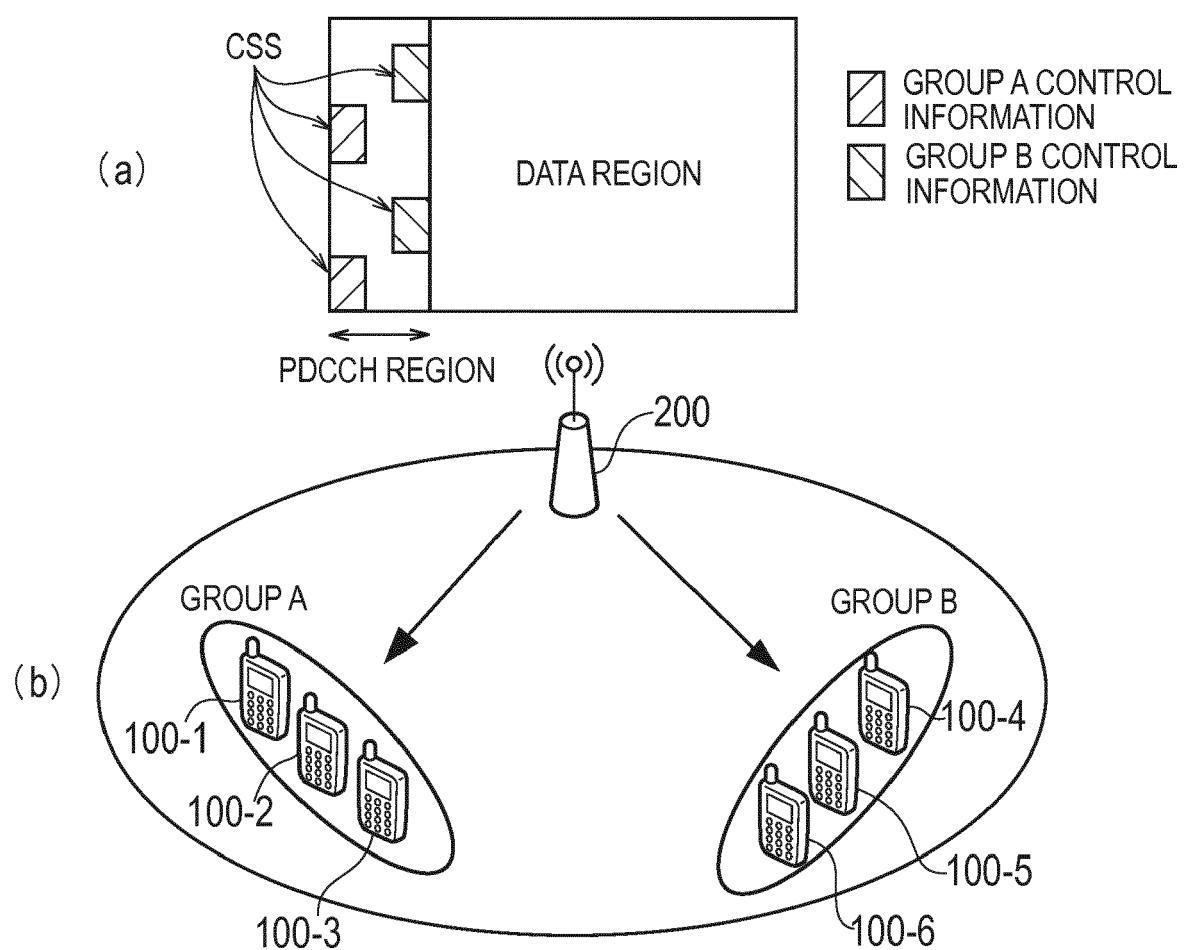
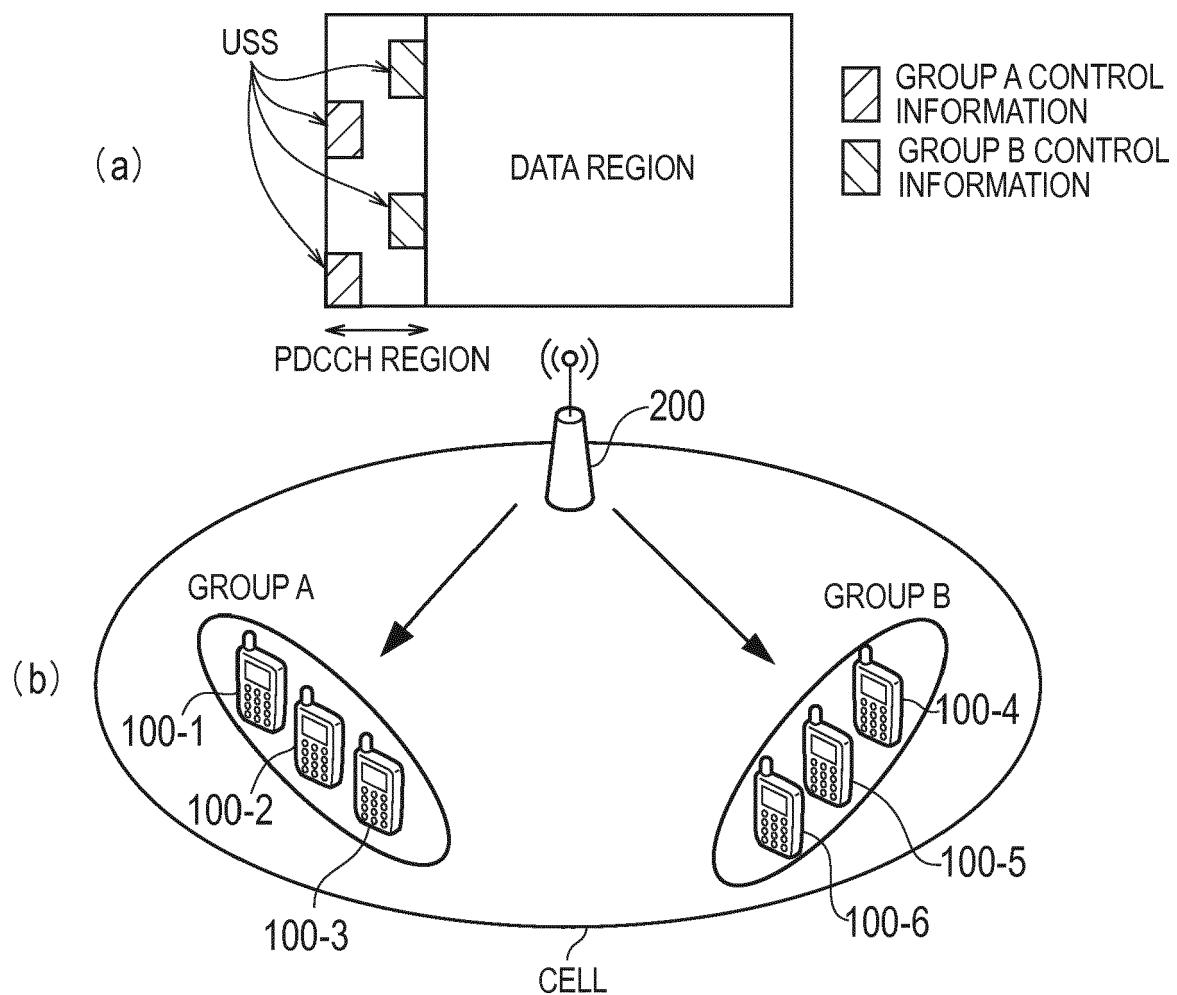


FIG. 14





## EUROPEAN SEARCH REPORT

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2	Place of search The Hague	Date of completion of the search 2 July 2019	Examiner Heinrich, Dietmar
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